

Air Force Successes & Challenges in Cr(VI) Minimization



**1st Lt Nicholas Herr
Materials Chemist
AF Corrosion Prevention and Control Office
AFRL/RXSSR**

Report Documentation Page				Form Approved OMB No. 0704-0188	
Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.					
1. REPORT DATE MAY 2011		2. REPORT TYPE		3. DATES COVERED 00-00-2011 to 00-00-2011	
4. TITLE AND SUBTITLE Air Force Successes & Challenges in Cr(VI) Minimization				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Air Force Research Laboratory, AF Corrosion Prevention and Control Office (AFRL/RXSSR), 325 Richard Ray Blvd, Bldg 165, Robins AFB, GA, 31098-1639				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution unlimited					
13. SUPPLEMENTARY NOTES Presented at the NDIA Environment, Energy Security & Sustainability (E2S2) Symposium & Exhibition held 9-12 May 2011 in New Orleans, LA.					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT Same as Report (SAR)	18. NUMBER OF PAGES 14	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			



Why Use Cr(VI)?

- **Very Effective Corrosion Inhibitor**
 - Arrests surface corrosion on legacy aircraft
 - Used in most demanding applications
- **Established Track Record**
 - Used in corrosion control for 40+ years
- **Organizational Inertia/Resistance to Change**
 - New specs/standards, processes, training
 - Multiple new technologies to replace Cr(VI)



Why Eliminate Cr(VI)?

- **Long Known to be a Carcinogen**
 - Inhalation causes lung cancer
 - Recognized by ACGIH, EPA, IARC
- **Increasingly Stricter OSHA regulations**
 - PEL reduced 52 $\mu\text{g}/\text{m}^3$ to 5 $\mu\text{g}/\text{m}^3$
- **International Pressure**
- **OSD Policy (Young Memo)**
 - Extraordinary action to eliminate Cr(VI)
- **DFARS Clause**
- **Diminished Manufacturing**

**Change is coming
prepare for a world without hex chrome**



AF Challenges - General



- **Technical Order \neq Use**
 - SPOs, OEMs are independent
- **Lack of continuity**
- **Cr(VI) on legacy systems**
 - Cr(VI) is familiar, arrests corrosion
- **Organizational Barriers**
 - Risky: few want to be first, accountable for failure



AF Successes – Non-Chrome Aluminum Pretreatments



- **Outer Mold Line Repainting**
- **Pantheon PreKote™ SP**
 - Adhesion promoter
 - C-130, C-5, F-16, T series
- **DEFT**
 - RECC 1015/3021
- **Boeing Commercial - 737**
 - Boegel EP II/AC 131



AF Challenges – Non-Chrome Aluminum Pretreatments



- **Outer Mold Line only**
 - Cr(VI) used elsewhere
- **Approved for use only under chromate primers**
 - Bulk of Cr(VI) volume contained in primer
 - Cr still relied upon for corrosion protection
- **No New Specs/Standards**
 - Alternatives are sole source
 - Non-Cr alternatives added to Cr(VI) spec (MIL-DTL-81706), weapon system approval required



AF Successes – Non-Chrome Primer



- **DEFT Non-Cr Primers**
 - F-35 44GN098 applied to interior/exterior at LMA
 - F-22 02GN084 approved for OML
 - F-15 02GN093 full PDM production, >25 a/c complete
 - Total Non-Cr System (RECC 1015+3021/02GN093/99GY013)
- **AkzoNobel Mg-rich Primer (Aerodur 2100)**
 - Promising so far



PreKote / Mg Rich Primer



- **PreKote™ SP Adhesion Promoter**
- **Akzo Nobel Magnesium-rich Primer (Aerodur 2100)**
 - Cathodic protection mechanism- sacrificial
- **Performance equal to Cr(VI)**
 - Lab/beach/flight testing
- **Full C-130 test in planning stages**
- **MIL-PRF-32239 Qualification**
- **CTIO's choice to meet USD(AT&L), Mr. Young letter**





AF Challenges – Non-Chrome Primer



- **Matching Cr(VI) performance**
 - Cr(VI) has 40+ years history
- **Legacy aircraft**
 - Pre-existing corrosion (KC-135, B-52)
- **Cost of Rework**
 - KC-135 JGAPP coating failure/repaint
- **Interior applications**
 - Legacy Cr(VI) for years to come



AF Challenges – Non-Chrome Primer



- **MIL-PRF-23377**
 - Originally QA for Cr(VI) primer
 - Non-Cr Type N added later (w/ SPO approval)
- **New technology = New spec**
 - Each Non-Cr substitute would require new spec
- **MIL-PRF-32239**
 - System spec, no mixing-and-matching components



AF Successes - Sealants



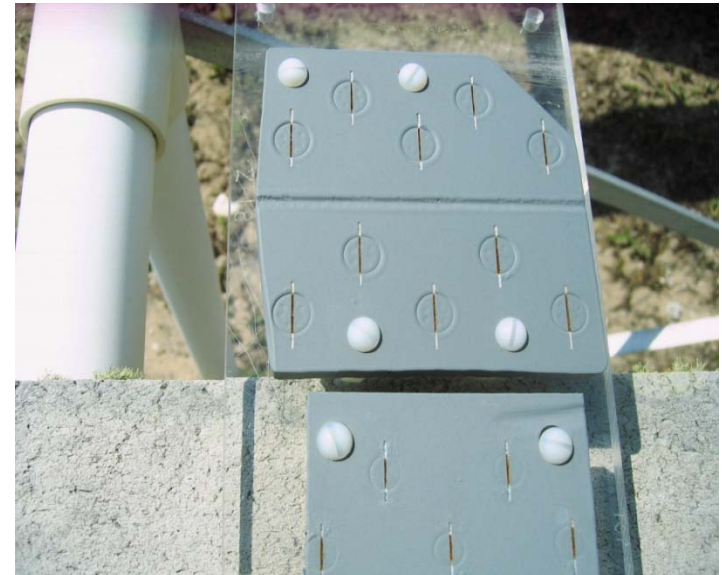
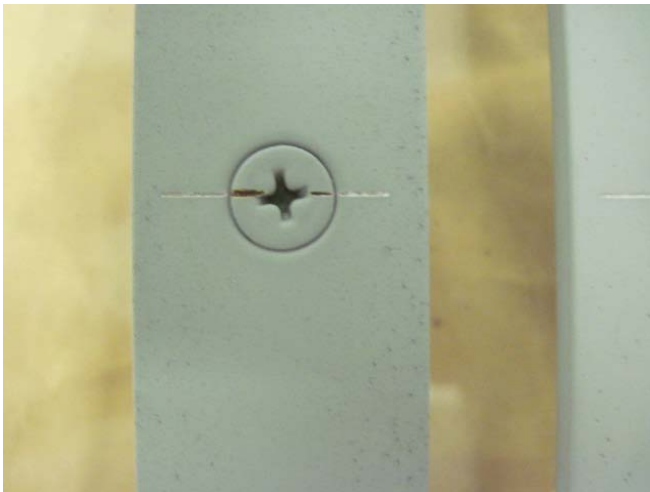
- **SAE AMS 3265 as Non-Cr substitute to MIL-S-81733**
 - T.O. 1-1-691 and 35-1-3
- **Increasing use of AVDEC pre-cured gaskets**
 - Virtually eliminates corrosion due to dissimilar metal contact
 - T.O.s
 - 1-1-691 *Cleaning and Corrosion Prevention and Control, Aerospace and Non-Aerospace Equipment*
 - 1-1-689 *Cleaning and Corrosion Control*
 - 35-1-3 *Corrosion Prevention and Control, Cleaning, Painting, and Marking of USAF Support Equipment (SE)*



Testing



- **Testing to Failure**
 - MIL-PRF-23377 only 2000 hrs neutral salt spray
 - New samples – galvanic couples
- **Testing Under Real World Conditions**
 - Laboratory \neq Exposure/Flight Testing
 - Improvements to ASTM B117
 - Accelerated Outdoor Testing





The Road Ahead



- **Sealant T.O. Changes**
 - T.O.s 35-1-3 and 1-1-691
 - SAE AMS 3265, Non-Cr alternative for MIL-S-81733
- **Support Equipment**
 - MIL-PRF-53022 replacing MIL-PRF-23377 in 35-1-3
- **Mg-Rich Primer Field Test**
- **MIL-PRF-32239 Coating System, Advanced Performance, For Aerospace Applications**



Questions?